PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference S30664PCT	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/EP2004/011212	International filing date *(day/month/year)* 07.10.2004	Priority date *(day/month/year)* 11.12.2003
International Patent Classification (IPC) or national classification and IPC INV. C09K19/52 C09K19/58 C09K19/60		
Applicant SONY INTERNATIONAL (EUROPE) GMBH et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 4 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in celectronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
08.07.2005	27.03.2006
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized officer Serbetsoglou, A Telephone No. +31 70 340-3425

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2004/011212

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

   Description, Pages

   1-15 as originally filed

   Claims, Numbers

   1-26 received on 28.07.2005 with letter of 29.07.2005

   Drawings, Sheets

   1/12-12/12 as originally filed

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

   * *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-26
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-26
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-26
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. State of the Art

The following documents (D) are referred to in this communication; the numbering will be adhered to in the rest of the procedure:

D1: XP000639763 JACQ P. ET AL.: "PRELIMINARY COMMUNICATION CHIRAL BUTADIENE-TRICARBONYL IRON LIQUID CRYSTAL COMPLEXES: RACEMATES AND ENANTIOMERS"

D2: EP 1 197 791 A (SONY INT EUROP GMBH ;UNIV DURHAM) 17 April 2002 **cited in the application**

D3: XP000854406 BARMATOV E.B. ET AL.: "INDUCTION OF THE CHOLESTERIC MESOPHASE IN HYDROGEN-BONDED BLENDS OF POLYMERS WITH A LOW MOLECULAR MASS CHIRAL DOPANT"

D4: XP002279441 BARMATOV E. B. ET AL.: "Cholesteric mesophase of the hydrogen-bonded blends of liquid crystalline ionogenic copolymers with a low molecular weight chiral dopant"

D5: XP002279442 TAKEDA M. ET AL.: "Synthesis and properties of trifluoromethylated chiral dopants for ferroelectric liquid crystals"

2. Amendments (Article 34(2)(b) PCT)

The amended claims, filed with the letter of 29.07.2005, do not introduce subject-matter which extends beyond the content of the application as filed, thus meeting the requirements of *Article 34(2)(b) PCT.*

2.Novelty (Article 33(2) PCT) , Inventive Step (Article 33(3) PCT)

The present application meets the criteria of *Article 33(1) PCT*, because the subject-matter of **claims 1-26** is new in the sense of *Article 33(2) PCT* and involves an inventive step in the sense of *Article*

33(3) PCT.

2.1.

Document **D2**, which is regarded as being the closest prior art to the subject-matter of **claim 1**, discloses (page 4, paragraph 26- page 6, paragraph 41, examples, claims) a liquid crystal mixture for liquid crystal cell comprising a liquid crystal material, which is "BL001" (formally E7)(TM Merck), and a dye, which has a permanent dipole and can be i.a. Morpip (which can form a complex with said LC material, as it is shown in figure 5 of the present application). A liquid crystal cell and the use of the dye in liquid crystal cells (anti-parallel aligned liquid crystal cell, PDLC cell, GH cell) and/or liquid crystal displays is also claimed.

The subject-matter of **claim 1** differs from document **D2** (see page 8, lines 55-58) in that there is 0.5 wt.% of Morpip (or even 1.0 wt.% of Morpip) in the liquid crystal mixture.

The subject-matter of **claim 1** is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may therefore be regarded as providing an alternative liquid crystal mixture comprising a liquid crystal material and an additive, which can form a complex with said LC material, said LC mixture having improved response times, more specifically turn-on-time and decay-time, improved dielectric anisotropy, increased grey scale response speed of the LC cells and no detrimental loss of LC alignment.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT), since it is neither disclosed nor suggested in **D2,** or in any of the documents of the international search report, that the use of 0.01-0.15 wt.% of said additive in such LC mixtures can solve the above problem. Document **D2** does not mention the possibility of using low concentrations of the additive and clearly teaches away from the subject-matter of **claim 1**.

The subject-matter of **claim 1** is therefore inventive (Article 33(3) PCT).

2.2. Other independent claims

The corresponding **independent claims 20, 23 and 25** relate to the use of the composition, a liquid crystal cell and a method of improving the response times, the dielectric anisotropy and the grey scale response speed of an LC cell. The same reasoning applies, *mutatis mutandis*, to the subject-

matter of the corresponding **independent claims 20, 23 and 25**, which therefore is also considered new and inventive.

2.3. Other dependent claims

Claims 2-19, 21-22, 24 and 26 are dependent on claim *1, 20, 23 and 25 respectively* and, as such, also meet the requirements of the PCT with respect to novelty and inventive step.

2.4.

Document **D1** discloses (whole document) mesogenic butadiene-tricarbonyl-iron complexes, which exhibit columnar, cholesteric, smectic A and smectic C* properties. Both smectic mesophases can potentially be used in switchable bistable electro-optic devices and all the mesogenic enantiomers can act as dopants by inducing ferroelectric properties when dissolved in a non-chiral smectic A or C phase. The additive (iron) forms a complex with a liquid crystal compound.

Document **D3** discloses (abstract) the preparation of a family of new hydrogen bonded complexes based on comb-shaped LC copolymers containing alkyloxy-4-oxybenzoic acid mesogenic fragments and chiral dopant molecules, derivatives of pyridine-4-carboxylic acid.

Document **D4** discloses (abstract) the preparation of a family of a new hydrogen-bonded complexes based on comb-shaped LC copolymers containing the monomer units of cyanobiphenyl derivative and n-alkyloxy-4-oxybenzoic acid with a chiral dopant on the base of 4-pyridinecarboxylic acid and L-menthol.

The formation of the complexes of **D1-D4** can implicitly be measured by the methods of **claims 3-6** of the present application. The MOPAC simulations are methods for the study of the chemical behaviour known to the person skilled in the art (see **D5** abstract).

None of the documents **D1 and D3-D5** discloses the use of 0.01-0.15 wt.% of said additive in such LC mixtures, the subject-matter of **claim 1-26** is therefore new and inventive over **D1 and D3-D5**.

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Claims

1. A composition comprising a liquid crystal material and an additive, preferably a dopant, wherein said additive is capable of forming a complex with said liquid crystal material, wherein said additive is present in an amount of 0.01-0.15 wt.% of the total composition.

2. The composition according to claim 1, wherein said liquid crystal material and said additive form a complex.

3. The composition according to claim 2, wherein said liquid crystal material and said additive form a complex, as measured by a method selected from the group comprising FTIR, UV-visible absorption, fluorescence, in particular polarized fluorescence, dielectric anisotropy and scanning near-field optical microscopy.

4. The composition according to any of the foregoing claims, wherein said liquid crystal material and said additive form a complex as simulated in MOPAC-simulations.

5. The composition according to claim 4, wherein said MOPAC-simulations comprise the following steps/conditions:
   in a computer environment,
   - providing a molecular structure of said liquid crystal material and a molecular structure of said additive,
   - optimizing each molecular structure individually by determining the lowest energy of formation, determining the AM1 and PM3 Hamiltonians and selecting the lowest energy molecular structure that is best fitted by both Hamiltonians,
   - bringing together the optimized individual molecules resulting from the previous step, allowing them to combine, taking into account the charges of atoms, the distribution of charges and the dipole moment of the molecular structures,
   - permutating the previous combination step a number of times, preferably in the range of from 100 – 1000 times, more preferably 200 – 800 times, even more preferably 400 – 600 times and most preferably about 500 times, thus allowing a complex, if any, of said liquid crystal material and additive molecules to form,

- in such complex of molecules, optimizing the structure of the individual molecules so as to determine the lowest energy of formation of the complex and the lowest energy state of the complex.

6. The composition according to claim 5, wherein said MOPAC simulations comprise the additional step:
   - selecting the complex having the lowest energy of formation and calculating from its structure the dipole moment.

7. A composition comprising a liquid crystal material and an additive, in particular according to any of the foregoing claims, wherein said additive is present in an amount of 0.05 – 0.12 wt.%, more preferably 0.08 – 0.11 wt.% and most preferably around 0.1 wt.% of the total composition.

8. The composition according to any of the foregoing claims, wherein said additive, when viewed on its own, has no permanent dipole or a dipole $\leq$1 Debye, preferably $\leq$0.1 Debye.

9. The composition according to claim 8, wherein said additive gains a dipole in the presence of said liquid crystal material and, preferably, upon complex formation with said liquid crystal material.

10. The composition according to any of claims 7 – 9, wherein said additive is L20 (2,4-dichloro-3,6-diethoxybenzoquinone).

11. The composition according to any of claims 1 – 7, wherein said additive has a permanent dipole, preferably a dipole $\geq$1 Debye, more preferably $\geq$0.1 Debye.

12. The composition according to claim 11, wherein said complex formed by said liquid crystal material and said additive has a dipole which is greater than the sum of the individual dipoles of said liquid crystal material and said additive on their own.

13. The composition according to any of claims 11 – 12, wherein said additive is selected from the group comprising MORPIP (2-{4-[(2,6-dimethylmorpholin-4-yl)(4-methylpiperidin-1-yl)methylene]cyclohexa-2,5-dien-1-ylidene}malononitrile), J6, and

10-γP3CNQ.

14. The composition according to any of the foregoing claims, wherein said additive is a dye.

15. The composition according to any of the foregoing claims, wherein said liquid crystal material is selected from the group comprising MLC-2038, ZLI-1695, E7 and ZLI-4792.

16. The composition according to any of the foregoing claims, wherein said additive is soluble in said liquid crystal material.

17. The composition according to any of the foregoing claims, wherein said liquid crystal material has a permanent dipole.

18. The composition according to any of claims 1 – 16, wherein said liquid crystal material has an induced dipole.

19. The composition according to any of the foregoing claims, wherein said composition has an order parameter of at least 0.5, preferably of at least 0.7, wherein the order parameter S is defined as:

$$S = \frac{A_{\parallel} - A_{\perp}}{A_{\parallel} - A_{\perp}},$$

wherein $A_{\parallel}$ and $A_{\perp}$ are the measured absorbance values when the director axis of a liquid crystal or liquid crystal mixture is parallel ($A_{\parallel}$) or perpendicular ($A_{\perp}$) to the propagation axis of an incident polarized light, wherein, more preferably, a parallel state can be achieved by: in the case of a liquid crystal (LC) with positive dielectric anisotropy - inserting a liquid crystal or liquid crystal mixture in a parallel (or antiparallel, or homogeneous) aligned sandwiched cell; and either wherein a perpendicular state can be achieved by either applying an electric or magnetic field to such parallel (or antiparallel, or homogeneous) aligned cell, or alternatively by inserting the liquid crystal or liquid crystal mixture in a homeotropic (or perpendicularly, or vertically) aligned cell;
in the case of a LC with negative dielectric anisotropy - inserting a liquid crystal or liquid crystal mixture in a homeotropic (or perpendicularly or vertically) aligned sandwiched cell; and either wherein a parallel state can be achieved by either applying an electric or

magnetic field to such homeotropic aligned cell, or alternatively by inserting the liquid crystal or liquid crystal mixture in a parallel (or antiparallel, or homogeneous) aligned cell.

20. Use of a composition according to any of the foregoing claims in a liquid crystal cell for a liquid crystal display.

21. Use according to claim 20, wherein said liquid crystal cell is a single pixel cell or a multiple pixel cell.

22. Use according to any of claims 20 – 21 for improving the grey scale response time speeds of said liquid crystal cell and/or for shortening the rise and/or decay times of said liquid crystal cell.

23. A liquid crystal cell comprising the composition according to any of claims 1 – 19.

24. Use of a liquid crystal cell according to claim 23 in a liquid crystal display.

25. A method of improving the response time and/or the dielectric anisotropy and/or the grey scale response speed of a liquid crystal, preferably in a liquid crystal cell, comprising the steps:
    - providing a liquid crystal,
    - adding an additive to said liquid crystal, wherein said additive is capable of forming a complex with said liquid crystal, wherein said additive is present in an amount of 0.01-0.15 wt.% of the total composition.

26. The method according to claim 25, wherein said liquid crystal and said additive are as defined in any of claims 1 – 19.